

# PATENT SPECIFICATION (11)

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DRAWINGS ATTACHED

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## (54) AN EAR-MUFF ASSEMBLY

(71) We, WORMALD BROTHERS INDUSTRIES LIMITED, a company incorporated in the State of New South Wales, Commonwealth of Australia, of 208 Young Street, Waterloo, New South Wales, 2017, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an ear-muff assembly such as is used in noisy situations to reduce the sound level at the ear drums.

An ear-muff assembly for this purpose may comprise two muffs designed to enclose the ears, these muffs being joined by a spring band which extends around the back of the neck or over the head and exerts a force to hold the muffs against the head and thus effect an air seal between the interiors of the muffs and the head. Each muff may comprise a plastics moulding of dish form having a mouth around which extends a flexible plastics sheeting surround, this surround being of hollow toroidal form and filled with flexible foamed plastics material such as that sold under the trade mark "ESTAFOAM", or with a liquid. A sound-absorbing material may be disposed in each muff; for example a layer of foamed plastics material may line the interior surface of the muff.

With an ear-muff assembly such as described in the preceding paragraph, it is desirable for the sake of comfort and adequate sealing of the muffs against the head that the pressure on the head should be evenly exerted over the whole area of contact between each ear-muff and the head. Thus the force exerted by each muff should be normal to the plane of the ring of contact between the muff and the head of the wearer.

According to the present invention, there is provided an adjustable ear-muff assembly comprising a pair of generally dish-form ear-muffs respectively adapted to engage over the ears of a human head, and a spring head band, or neck band, with

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opposite end portions which extend slidably through respective guide channels provided therefor on the exterior of the ear-muffs for retention of the muffs on the band, inner boundary surface portions of the said guide channels being constituted by respective convex surface portions with which respective inner main faces of the said end portions are in substantially point contact, and each of the said guide channels having a depth (perpendicular to the inner main face of the end portion extending through the channel) which is greater than the thickness of the end portion extending through the channel so that the location and inclination of the ear-muffs relative to the band are adjustable in accordance with the shape of the head of a person wearing the assembly. It will be appreciated that, in the present context, an "inner" face or surface is one that is closer to the head of the wearer of the assembly when in use.

The convex surface portions bounding the respective guide channels provided on the ear-muffs may be substantially spherical. In this case, the end portions of the head or neck band are preferably arcuately curved so as to extend in a common plane which intersects the convex surface portions, the respective inner radii of curvature of the end portions in this plane being equal to or greater than the respective radii of curvature of the convex surface portions in the plane. Further, the centre of curvature of each convex surface portion preferably lies at the centre of the area defined by a ring along which the ear-muff provided with the convex surface portion in question is adapted to contact the head of a person wearing the assembly.

In an ear-muff assembly embodying the invention, the depth of each guide channel—as measured perpendicular to the inner main face of that end portion of the head or neck band extending through the channel—is preferably several times greater than the thickness of the end portion in question. The guide channel provided on the exterior of each ear-muff may be formed in a mounting pad which is either secured to or

integral with an outer surface portion of the ear-muff. Lateral boundary surface portions of each guide channel may be provided by opposed lugs which project outwardly beyond the inner boundary surface portion of the channel at respective opposed sides of that inner boundary surface portion and have respective flanged end portions which project towards one another so as to limit movement of the associated end portion of the band outwardly of the inner boundary surface portion of the channel, there remaining between the respective flanged end portions of the lugs a gap which is narrower than the width of the associated end portion of the band. Alternatively, each guide channel may take the form of a slot having a lateral boundary which extends completely around that end of the band which extends through the channel.

Reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a perspective view of an ear-muff assembly embodying the invention,

Figure 2 is a plan view of the assembly from below,

Figure 3 is a rear elevational view of the assembly,

Figure 4 is a side elevational view of the assembly as rotated through 90 degrees about a horizontal axis,

Figure 5 is an elevational view in section, and to an enlarged scale, of an ear-muff of the assembly,

Figure 6 is a view of part of the muff sectioned along the line A—B of Figure 5 and rotated through 90° about a horizontal axis, and

Figure 7 is a fragmentary elevational view, similar to that of Figure 5, of a modified form of the muff.

The illustrated ear-muff assembly comprises two ear-muffs 1 and 2 each of which comprises a plastics moulding of dish form which, as seen in Figure 4, is of approximately elliptical cross-section transverse to the direction in which the moulding is dished. Each of the dish-form plastics mouldings has a mouth defined by a rim 3 (see Figure 5). A surround 4 of flexible sheet plastics material is clipped to the rim 3 of each muff mouth, the surround being of hollow toroidal form and filled with flexible foamed plastics material 5 so as to provide a muff cushion which is intended to contact the head of a person wearing the assembly along a ring extending around the particular ear to which the muff in question is applied.

A mounting pad 6 is secured to or formed integrally at the exterior of each muff opposite the centre of the mouth of the muff.

Each mounting pad has an outer surface portion (relative to the head of a person wearing the assembly) of convex curvature in two planes at right angles to one another. Preferably, the radii of curvature of each such outer surface portion in these respective planes are equal, so that the surface portion is spherical. In this case, the centre of curvature of each such outer spherical portion preferably lies at the centre of the area defined by the ring along which the ear-muff provided with the convex surface portion in question is adapted to contact the head of a person wearing the assembly. This is indicated in Figure 5, where the radius of the spherical outer surface portion of the mounting pad 6 provided on the exterior of the ear-muff 1 is denoted by  $r$  and the centre of curvature of this surface portion is seen to be situated in the plane of and at the centre of the annular head-contacting surface of the surround 4 clipped to the rim 3 of the muff.

Each of the mounting pads 6 is made of a material having a limited degree of resilience, such as a hard rubber, and, except in the case of Figure 7, has, as seen in Figure 5, opposed upper and lower lugs 7 and 8 which project outwardly beyond the spherical outer surface portion of the pad so as to provide respective lateral boundary surface portions of a horizontally extending channel 11 with an inner boundary surface portion (relative to the head of a person wearing the assembly) which is constituted by the spherical outer surface portion of the pad. The lugs 7 and 8 have respective inturned flanged end portions 9 and 10 which project toward one another so as to provide respective outer boundary surface portions of the channel 11. However, the flanged end portions 9 and 10 of the lugs 7 and 8 do not meet one another. As will be apparent from Figures 1 to 4, the illustrated ear-muff assembly includes a spring neck band 12 opposite end portions 13 and 14 of which respectively extend through the channels 11 provided by the respective mounting pads 6 of the ear-muffs 1 and 2. Because each end portion of the neck band is wider than the gap between the flanged end portions 9 and 10 of each pair of lugs 7 and 8, the end portion of the band is retained in the relevant channel 11 against movement outwardly of the inner boundary surface portion of the channel by the flanged end portions of the lugs.

The inner main face (relative to the head of a person wearing the assembly) of each of the end portions 13 and 14 of the band 12 is in substantially point contact with the inner boundary surface portion of the channel 11 through which the relevant end portion of the band extends. Further, each of the channels 11 has a depth—as measured

perpendicular to the inner main face of the end portion of the band extending through the channel—which is several times greater than the thickness of the end portion. In addition, each of the channels 11 is of sufficient width to permit the muffs 1 and 2 to be slid along the respective end portions 13 and 14 of the neck band 12.

The neck band 12 is formed from a flat strip of spring steel. The end portions 13 and 14 of the band are each arcuately curved to an extent of about 155° with a curvature whose radius is  $1\frac{13}{16}$  inches. The arcuately curved end portions 13 and 14 of the band 12 are joined by a neck-encircling portion 15 of the band which has a radius of  $2\frac{1}{2}$  inches and extends over an arc of about 140°. The width of the band 12 is  $\frac{1}{2}$  inches and consequently the channels 11 are of at least this width. When the assembly is fitted to a head, the radius of curvature of the neck-encircling portion 15 of the band 12 will generally increase to an extent determined by the size of the head.

As will be apparent from Figure 5 and Figure 6, the latter of which is simply a view of the mounting pad 6 seen in Figure 5, each of the channels 11 is symmetrical relative to a plane extending centrally there-through transversely between the lugs 7 and 8 bounding the channel and relative to a perpendicular plane which extends centrally through the channel transverse to the longitudinal extent of the channel. However, with a view to accommodating the head taper of the average wearer, the channel is positioned so that the first-mentioned plane makes an angle  $\alpha$  of approximately 10° to 15° to a plane which passes centrally and horizontally through the relevant ear-muff when the muff is in the orientation thereof shown in Figure 5, i.e. with the surround 4 extending in a vertical plane.

Because of the substantially point contact between the inner main faces of the respective end portions 13 and 14 of the neck band 12 and the inner boundary surface portions of the respective channels 11, and on account of the dimensioning of the channels 11 and the end portions 13 and 14 relative to one another, each of the ear-muffs can rotate to a limited extent universally relative to the band 12. This has the result that the force exerted on the head of a person wearing the assembly by each muff is normal to the plane of the ring along which the surround 4 of the muff contacts the head. To make the assembly suitable for use on heads of different sizes, the muffs 1 and 2 can be slid along the respective end portions 13 and 14 of the band 12 as required to bring the muffs into positions in which they respectively engage over the ears of a person wearing the

assembly. To hinder the muffs 1 and 2 from sliding off the respective end portions 13 and 14 of the neck band 12, the end portions are provided with respective plastics end caps 18 (see Figure 2).

As indicated in Figure 5, the interior surfaces of each muff moulding is lined with flexible foamed plastics material or other acoustically advantageous material 16. A layer of lead-impregnated flexible plastics material may be placed between these surfaces and the foamed plastics material.

In the case of the modified ear-muff shown in Figure 7, the flanged end portions 9 and 10 of the muff shown in Figure 5 can be thought of as joining one another so that, in place of the open channel 11, a closed slot-form channel 17 is provided for the relevant end portion of the neck band 12. In other respects, the modified muff is the same as that illustrated in Figure 5. To bring the modified muff into position on the relevant end portion of the neck band 12, this end portion is slipped through the channel 17 before attachment of the associated end cap 18 to the end portion.

#### WHAT WE CLAIM IS:—

1. An adjustable ear-muff assembly comprising a pair of generally dish-form ear-muffs respectively adapted to engage over the ears of a human head, and a spring head band, or neck band, with opposite end portions which extend slidably through respective guide channels provided therefor on the exterior of the ear-muffs for retention of the muffs on the band, inner boundary surface portions of the said guide channels being constituted by respective convex surface portions with which respective inner main faces of the said end portions are in substantially point contact, and each of the said guide channels having a depth (perpendicular to the inner main face of the end portion extending through the channel) which is greater than the thickness of the end portion extending through the channel so that the location and inclination of the ear-muffs relative to the band are adjustable in accordance with the shape of the head of a person wearing the assembly.

2. An assembly as claimed in claim 1, wherein the said convex surface portions are substantially spherical.

3. An assembly as claimed in claim 2, wherein the said end portions are arcuately curved so as to extend in a common plane which intersects the said convex surface portions, the respective inner radii of curvature of the said end portions in the said common plane being equal to or greater than the respective radii of curvature of the said convex surface portions in that plane.

4. An assembly as claimed in claim 3,

wherein the centre of curvature of each of the said convex surface portions lies at the centre of the area defined by a ring along which the ear-muff provided with the convex surface portion in question is adapted to contact the head of a person wearing the assembly.

5 An assembly as claimed in any preceding claim, wherein the said depth is several times greater than the said thickness.

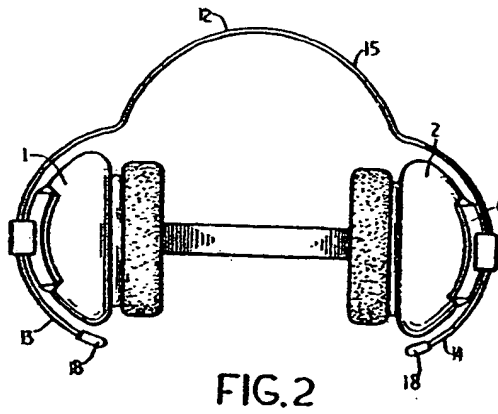
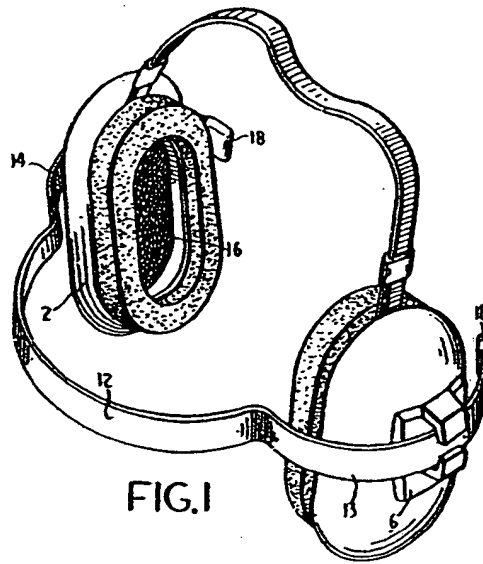
10 6. An assembly as claimed in any preceding claim, wherein each of the said guide channels has lateral boundary surface portions which are respectively provided by opposed lugs that project outwardly beyond the inner boundary surface portion of the channel at opposite sides of that inner boundary surface portion and have respec-

tive flanged end portions which project towards one another so as to limit movement of the associated end portion of the band outwardly of the inner boundary surface portion of the channel. 20

7. An ear-muff assembly substantially as hereinbefore described with reference to Figures 1 to 6, or Figures 1 to 6 as modified by Figure 7, of the accompanying drawings. 25

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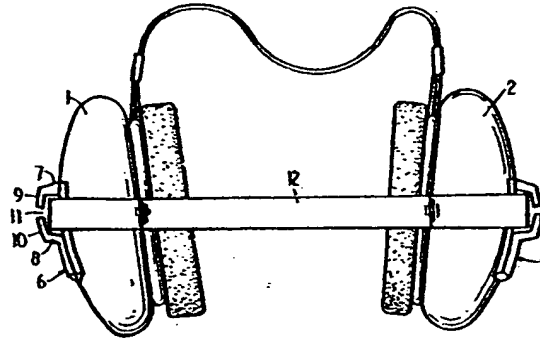


FIG.3

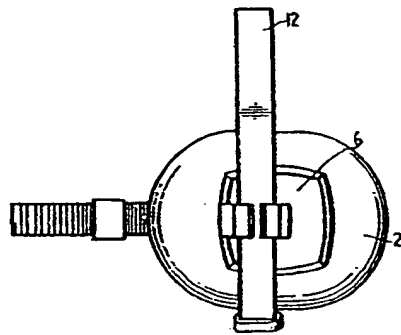


FIG.4

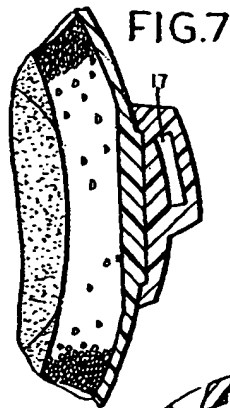


FIG. 7



FIG. 6

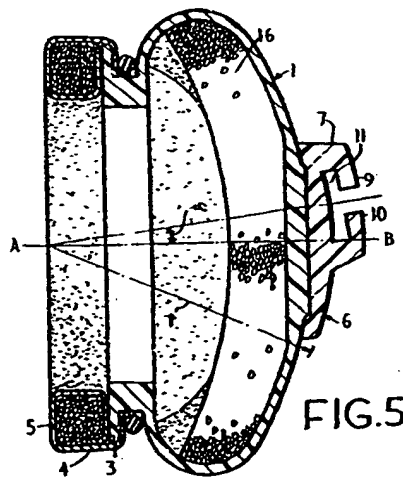


FIG. 5